



## Denver's Urban Ground-Water Quality: Nutrients, Pesticides, and Volatile Organic Compounds

A recent study by the U.S. Geological Survey (USGS) under the National Water-Quality Assessment (NAWQA) program characterized the ground-water quality in a part of the Denver, Colorado, metropolitan area. The study provides an assessment of water-quality conditions in an alluvial aquifer that drains into the South Platte River. Thirty wells randomly distributed in residential, commercial, and industrial land-use settings were sampled once in 1993 for a broad range of compounds. Nutrients, pesticides, and volatile organic compounds (VOC's), all of which are generally associated with human activities, frequently were detected in the urban wells sampled. Nutrients and VOC's occasionally exceeded drinking-water standards.



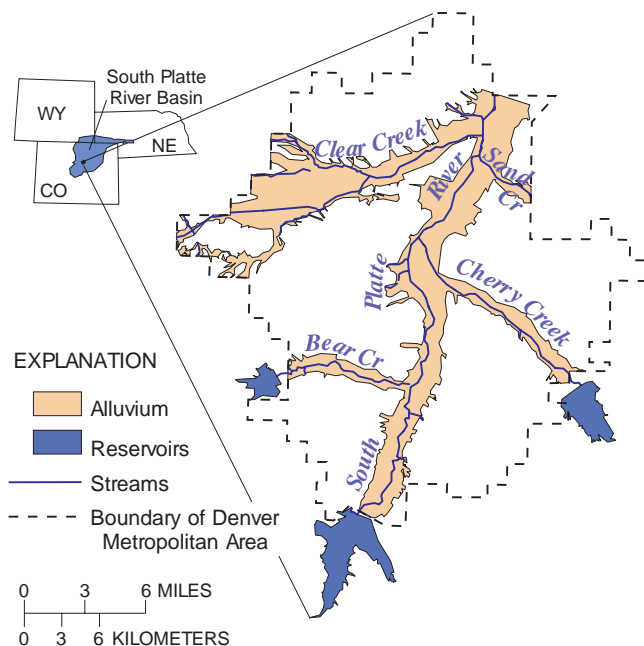
Colorado currently is one of the fastest growing states in the country, and the largest population center in the state is the Denver metropolitan area, which also is experiencing rapid growth. The continued urbanization of the Denver area might affect the quality of the ground-water resource that it overlies. It is difficult, however, to measure specific effects of the urban land-use setting without an assessment of background water-quality conditions. The alluvial aquifer beneath Denver is particularly vulnerable to human factors affecting the quality of the ground-water resource because of its shallow water table and high permeability. A decrease in the quality of water in the alluvial aquifer could have important consequences to local users.

In 1993, the USGS sampled 30 existing wells randomly distributed throughout the Denver metropolitan area, all of which were completed in the unconsolidated sands and gravels that fill the river and creek valleys. Most water pumped from these alluvial deposits is for industrial and commercial uses; a small amount is withdrawn for public consumption (after treatment and dilution) and for the irrigation of lawns and gardens.

Nutrients, in particular nitrogen and phosphorus compounds, often are associated with human and animal wastes, fertilizers, and detergents. These compounds can come from natural sources; however, the natural contribution from the sediments in the alluvial-aquifer system probably is very

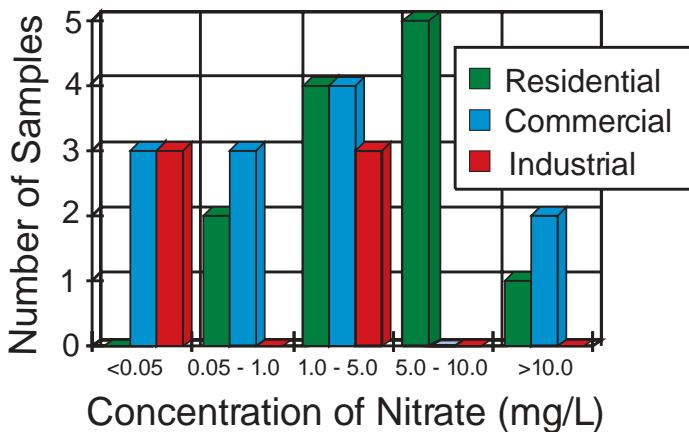
small. The concentrations of nutrients detected in this study, therefore, are considered to be derived primarily from urban land-use practices.

Nitrate, the most common nitrogen compound, has a U.S. Environmental Protection Agency (USEPA) maximum contaminant level (MCL) for drinking water of 10 milligrams per liter (mg/L) as nitrogen. In this study, only 3 of the 30 ground-water samples exceeded this level. The concentrations averaged 4 mg/L and ranged from nondetectable (less than 0.5 mg/L) to 24 mg/L. Higher nitrate concentrations were detected in residential and commercial areas; the industrial areas had lower concentrations or no nitrate detections.



Dissolved phosphorus concentrations generally were low. The average concentration was 0.3 mg/L, and the range was from nondetectable (less than 0.01 mg/L) to 7 mg/L. Eighteen of the 30 samples were at or below the detection limits for phosphorus. Elevated phosphorus concentrations in ground water often have been associated with human activities, but phosphorus does not seem to be a ground-water quality concern at this time.

## Distribution of Nitrate by Concentration and Land Use



**Pesticides, which include herbicides and insecticides, were prevalent in the Denver alluvial ground water, occurring in 90 percent of the wells sampled.**

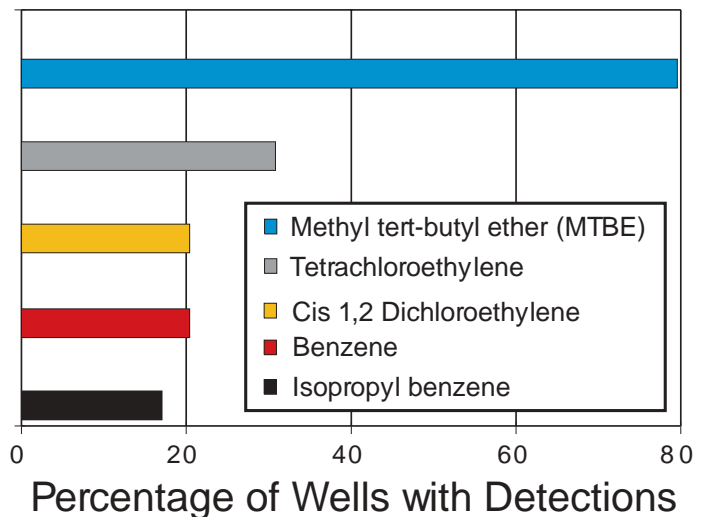
The concentrations of pesticide compounds detected in this study were low (never exceeding a MCL), and there were only 9 compounds detected out of the 82 analyzed. However, pesticide compounds were detected in residential, commercial, and industrial land-use settings throughout the metropolitan area and were not limited to any particular land use. Though the concentrations of pesticides were low, these compounds might be of concern in the future if they persist and accumulate in the ground water. Pesticides are not included in most water-quality investigations nor are they removed by conventional water-treatment practices. Manufacture of some of the pesticides detected in this study was banned over three decades ago.

The detection of volatile organic compounds (VOC's) in ground water also is an indication of the effect of urban land use on the quality of ground water. VOC's generally are petroleum compounds and solvents, and they can enter the ground-water system through a number of pathways: spills on the land surface; leaking underground storage tanks; improper disposal, such as "over the back fence"; and even automobile emissions washed onto the land surface by precipitation.

**Volatile organic compounds were detected in 86 percent of the wells sampled in this study and occasionally exceeded the USEPA's Maximum Contaminant Levels by large amounts. Thirty-one of the 59 compounds analyzed were detected at least once.**

One VOC compound, methyl tert-butyl ether (MTBE), a gasoline additive designed to reduce air pollution, was detected in almost 80 percent of the wells sampled. The wide-spread detections of MTBE suggests a possible nonpoint source of MTBE to Denver's ground water.

## Five Most Frequently Detected VOC's



One other constituent analyzed in urban ground water that might be related to human activities is uranium, a trace element that also occurs naturally. Uranium had elevated levels in the alluvial ground water of the Denver metropolitan area. The average uranium concentration for this study was 24 micrograms per liter ( $\mu\text{g/L}$ ), which is slightly higher than the proposed USEPA drinking-water MCL of 20  $\mu\text{g/L}$ . Uranium concentrations in ground water in the study area ranged from less than 1 to 80  $\mu\text{g/L}$ . Twelve of the 30 samples collected exceeded the proposed MCL. It is likely that the source for the elevated concentrations of dissolved uranium in the alluvial ground water is from the minerals present in the sediments that make up the aquifer and not the result of effects from the urban land-use setting.

Information on technical reports and hydrologic data related to NAWQA can be obtained from:

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